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ORIGINAL RESEARCH ARTICLE

Effect of different doses of vermicompost on growth, yield and quality of radish (*Raphanus sativus* L. cv. Mino Early)

Dipesh Dulal[1*], Deepshikha Baral[1], Abichal Poudel[2], Karuna Kafle[2] and Bishal Shrestha[3]

[1]Nepal Polytechnic Institute (NPI) Bharatpur-11, Chitwan, NEPAL
[2]G.P. Koirala College of Agriculture and Research Center, Morang, NEPAL
[3]Assistant Professor, Department of Horticulture, AFU Rampur, NEPAL
[*]Corresponding author's E-mail: dipeshdulal.dd@gmail.com

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ABSTRACT

A field experiment was conducted at Horticulture farm of Nepal Polytechnic Institute (NPI) Bharatpur-11, Chitwan to study the effects of different doses of vermicompost on growth, yield and quality of radish (*Raphanus sativus* L. cv. Mino Early) from January 2020 to March 2020. Five different doses (0 ton, 5 ton, 10 ton, 15 ton, and 20 ton per hectare) of vermicompost were taken as treatments and the experiment was replicated four times. The experiment was set up in Randomized Complete Block Design (RCBD). The result of the study showed that there was a significant effect of different doses of vermicompost on plant height, the number of leaves per plant, spreading of the plant, root length, root weight per plant, root diameter, and root yield at harvesting. The maximum plant height, the maximum number of leaves per plant and maximum plant spreading in radish plant on vermicompost application was recorded every 30, 45 and 60 days after sowing (DAS). The maximum root length (29.60 cm), maximum root diameter (36.27 mm), maximum root weight (191.8 g), maximum biomass weight (241.6 g/plant), maximum root yield (47.9 ton/ha), were recorded on applying 15 ton/ha vermicompost at 60 DAS. The control treatment showed the minimum vegetative growth and yield. Among the different doses of vermicompost, the overall performance of radish was found better in 15 ton/ha of vermicompost. Statistical analysis showed no differences among (5 ton, 10 ton, 15 ton, 20 ton per hectare of vermicompost) applications. Hence, 5 ton per hectare of vermicompost application will be best for radish production in Chitwan.

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INTRODUCTION

Radish (*Raphanus sativus* L.) is one of the most popular root vegetable crops grown in tropical and temperate regions (Kumar *et al*., 2014), but it is also grown in cool climatic zones in Nepal (Poon *et al*., 2004). It is consumed raw as a salad or cooked as a vegetable and is a good source of vitamin C and minerals like calcium, potassium, and phosphorus. It is also used for neurological headaches, sleeplessness, and chronic diarrhea (Jadhav *et al*., 2014). Radish is cultivated in an area of 18,250 hectares with a production of 2,87,200 metric tons in 2018/19 (MoALD, 2020). Radish can be grown in almost all types of soil with less care; low production cost and has wide adaptability which increases its cultivation. Radish is a short-duration and fast-growing crop so; its root growth and development should be uninterrupted. The growth and development of radish greatly depend upon the climatic condition and nutrient status of the soil (Tripathi *et al*., 2017). Optimum nutrition should be provided through organic, inorganic, and bio-fertilizer sources for smooth production (Sandeep *et al*., 2014). The application of chemical fertilizers to the crop is hazardous to the environment and is cost expensive. To overcome the detrimental effects of chemicals, alternative organic sources of nutrients should be used (Kumar *et al*., 2014). Application of organic fertilizers,

vermicompost, compost, biofertilizer, and low-dose chemical fertilizer has increased the production parameters of radish (Subramani *et al*., 2010, Kiran *et al*., 2016).

Vermicompost, excreta of earthworm, is capable of improving soil health and nutrient status and is an excellent soil additive made up of digested compost (Adhikary, 2012). Earthworms consume and fragment the organic wastes into finer particles by passing them through a grinding gizzard and derive their nourishment from microorganisms that grow upon them. Vermicompost can increase crop production and prevent harmful pests, is eco-friendly, and is ideal organic manure for better growth and yield of many plants (Reddy *et al*., 1998; Joshi *et al*., 2015). The study has attempted to evaluate the comparative efficacies of different doses of vermicompost on the Radish crop.

MATERIALS AND METHODS

Site selection

The experiment was conducted at the Horticulture farm of Nepal Polytechnic Institute (NPI) Bhojad-11, Bharatpur, Chitwan, Nepal. The experimental site lies in 27°41'35"N latitude and 84°26'57" E longitude. The experimental site lies in the tropical belt of the country with hot summer and cold winter. The experiment was carried out from 11th January 2020 to 11th March 2020.

Soil condition

The soil of the experimental site was moderately acidic (PH 6.2), total nitrogen was (0.25% N), phosphorous (P_2O_5 472.43 mg/kg soil), potassium (K_2O 13.95 mg/kg soil), and organic matter (4.872 %).

Seed and vermicompost

The variety "Mino Early" was used for the study and quality seed was obtained from the the distributor of the nearby seeds located in Sahid Chowk, Naryangadh, Chitwan. Vermicompost was also obtained from the nearest vermicompost distributor. A total of 40 kg of vermicompost was applied in 16 plots. The nutrients content in vermicompost varied depending on the waste material that is being used for compost preparation. The common nutrients content in vermicompost is organic carbon 13.4%, nitrogen 1.6%, phosphorus 1.02%, potassium 0.73%, and other micronutrients in a small amount.

Land preparation

The field was ploughed once, harrowed twice followed by planking to level the land, after leveling the clods were broken and weeds and other unwanted plant stubbles were removed. Twenty plots raised by 15 cm were prepared to facilitate proper root development. The required amount of vermicompost was weighed separately for each treatment before field application. Then, the required quantity of vermicompost was incorporated and mixed thoroughly in the soil the same day before seed sowing.

Experimental design

The experiment was set up in a Randomized Complete Block Design (RCBD) with 5 treatments and each treatment was replicated 4 times.

Treatment details

T_1- Control (Without vermicompost application)
T_2- Vermicompost (5 ton/ha)
T_3- Vermicompost (10 ton/ha)
T_4- Vermicompost (15 ton/ha)
T_5 - Vermicompost (20 ton/ha)

Seed sowing and intercultural operation

The seeds were uniformly drilled on the well-prepared raised beds @ 3 seeds per hill at the depth of 2-3 cm throughout the field experiment. Line sowing was done and plant to plant (P-P) 20 cm and row to row (R-R) 20 cm distance was maintained throughout the whole experimental field. The Mino Early variety of radish seed was sown on the 11th of January 2020. Light irrigation was immediately applied after seed sowing and then the second, third and fourth irrigation was applied after 5-7 days intervals. Proper development of roots was facilitated by one weeding and one earthing up during the early growth stage of the plant. Tagging of the plant was done in every plot to recognize the treatments during the research period for data collection. Imidacloprid was applied @ 2 ml/liter of water to control the aphids and mancozeb @ 2g/liter of water to control *Alternaria* leaf spot which was a very serious pest of radish during the research period. Harvesting was done manually by pulling the roots when they reached their marketable size.

Observation recorded

The observation was taken randomly from selected 10 plants from 3 standards rows of each plot and their mean was calculated. The data were collected on different parameters viz. vegetative parameters: plant height (cm), number of fully opened leaves per plant, spreading of plants (cm)), yield parameters: biomass weight (g), root weight (g), yield per plot (kg), quality parameters: edible root length (cm), root diameter (mm) at 30 DAS, 45DAS and 60DAS. The plant height (cm) was measured from the base just above the soil surface to the top of the plant until maturity using a measuring tape. The number of leaves per plant was counted till maturity. Further, the root length (cm) was measured from the crown to the distal end of the root by a manual scale and a vernier caliper was used to measure the root diameter (mm). Furthermore, the yield of each treatment was calculated, based on that yield of each treatment, the yield per ha (ton/ha) of each treatment was calculated.

Statistical analysis

The data of the experiment was entered in Microsoft Excel and analyzed using GenStat computer-based statistical data analysis software for analysis of variance (ANOVA) and means were separated by DMRT at a 5 % level of significance.

RESULTS AND DISCUSSION

Growth parameters

The effect of different doses of vermicompost on plant height at 30 DAS, 45 DAS, and 60 DAS is presented in Table 1. At 30 DAS, the maximum plant height was recorded in plots applied with T_4 (15 ton/ha) vermicompost followed by T_3 (10 ton/ha) and T_5 (20 ton/ha), and the minimum plant height was obtained in the control treatment (T_1). At 45 DAS and 60 DAS plots treated with T_4 (15 ton/ha) vermicompost showed maximum plant height which was statistically at par to 5 ton/ha followed by T_5 (20 ton/ha) and T_3 (10 ton/ha). Minimum plant height was obtained in control (T_1-without vermicompost) at 45 and 60 DAS. This result is favored by the study conducted by Politud, 2016 who recorded the maximum plant height in radish on applying 15 ton/ha of vermicompost. Khede *et al.* (2019) also reported the increase in plant height by applying vermicompost with the integration of NPK.

Effect of different doses of vermicompost on plant spreading

The data showing the plant spreading of radish (Mino Early) as affected by different doses of vermicompost are presented in Figure 1.

The results of the study showed that there was no significant difference between treatments on plant spreading of radish (Mino Early) at 30 DAS, 45 DAS, and at (60 DAS) as shown in the Figure 1. At 30 DAS, T_3 (10 ton/ha) showed the highest plant spreading which was statically at par with T_2 (5 ton/ha) followed by T_4 (15 ton/ha) and T_5 (20 ton/ha) while the least plant spread was shown by plot treated with T_1 (Control). At 45 DAS, the highest plant spreading was observed in the treated plot of T_2 (5 ton/ha) followed by T_5 (20 ton/ha) and T_1 (control) whereas, the least plant spreading was observed in plot treated with T_3 (10 ton/ha). Similarly, at 60DAS plot treated with T_4 (15 ton/ha) showed maximum plant spreading followed by a plot treated with T_3 (10 ton/ha) and T_5 (20 ton/ha) while the minimum plant spreading was seen in plot treated with T_1 (without vermicompost). The increase in plant spreading on increasing doses of vermicompost might be due to favorable conditions created by vermicompost (Raddy *et al.*, 1998; Kumhar, 2004). Jat (2015) also reported the greatest plant spreading in the vermicompost treated plot.

Effect of different doses of vermicompost on number of leaves per plant

The data showing the effects of different doses of vermicompost on Mino Early radish on the number of leaves per plant for each treatment are presented in Figure 2. The result of the study showed that there was no significant difference between treatments with different doses of vermicompost on the number of leaves per plant radish (Mino Early) at 30 DAS, 45 DAS, and 60 DAS.

At 30 DAS the maximum number of leaves per plant (6.67) was obtained in plots treated with T_3 (10 ton/ha vermicompost) which was on par with T_5 (20 ton/ha) followed by T_4(15 ton/ha) and T_2 (5 ton/ha) whereas, the minimum number of leaves per plant was obtained in plots treated with T_1 (without vermicompost). Similarly, the maximum number of leaves per plant was obtained in plots treated with T_5 (20 ton/ha) followed by T_3 (10 ton/ha) and T_4 (15 ton/ha) at 45 DAS. Likewise, at 60 DAS plot treated with T_3 (10 ton/ha) showed the maximum number of leaves per plant and was followed by T_2 (5 ton/ha) and T_5(20 ton/ha). The minimum number of leaves per plant was obtained in plots treated with T_1 (without vermicompost) at 30, 45, and 60 DAS. Jaisankar (2018) also reported highest number of leaves per plant in the plot applied with higher dose of vermicompost. The increase in a number of leaves per plant may be due to the availability of vital macro and micronutrient with vermicompost application (Jaisankar, 2018). Uddain *et al.* (2010) also found a higher leaf number in vermicompost treatment among other organic fertilizer treatments in radish crops. Mohmmad *et al.* (2015) also reported the highest number of leaves per plant on application of vermicompost and RDF which may be due to slow release of nutrients through vermicompost.

Table 1. Average plant height at different DAS of radish as affected by different doses of vermicompost, in Bharatpur, Chitwan, 2020.

Treatments (doses of vermicompost)	Plant height (cm)		
	30 DAS	45 DAS	60 DAS
T1(control)	9.31^{c}	16.07^{b}	19.61^{b}
T2(5ton/ha)	12.71^{b}	20.65^{a}	23.67^{a}
T3(10ton/ha)	14.18^{a}	21.40^{a}	25.08^{a}
T4(15ton/ha)	14.36^{a}	22.70^{a}	25.79^{a}
T5(20ton/ha)	14.16^{a}	22.12^{a}	25.25^{a}
Mean	12.94	20.59	23.88
SEM (±)	0.41	0.66	0.82
LSD (5%)	1.26***	2.05***	2.53**
CV (%)	6.3	6.5	6.9

Means followed by the same letter(s) in a column are not significant at 5% level of significance as determined by DMRT.

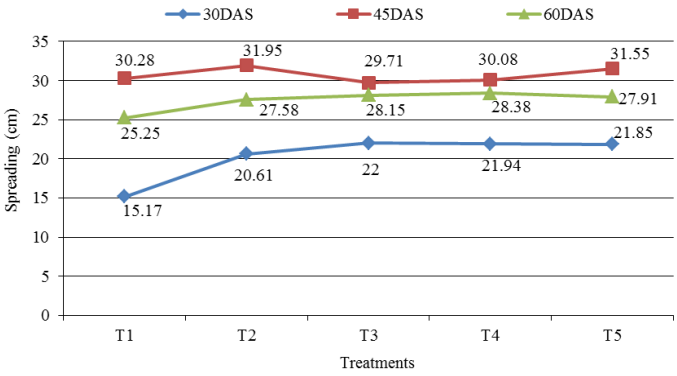

Figure 1. *Spreading of the plant as affected by different doses of vermicompost, in Bharatpur, Chitwan, 2020.*

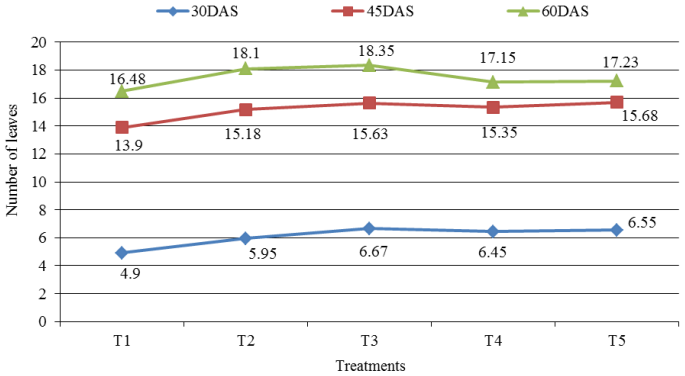

Figure 2. *Number of leaves per plant as affected by different doses of vermicompost in Bharatpur, Chitwan, 2020.*

Table 2. Average root length (cm) and diameter (mm) of radish as affected by different doses of vermicompost, in Bharatpur, Chitwan, 2020.

Treatment (doses of vermicompost)	Average root length (cm)	Average root diameter (mm)
T1(control)	23.42[b]	24.84[b]
T2(5ton/ha)	27.63[a]	35.24[a]
T3(10ton/ha)	29.01[a]	35.63[a]
T4(15ton/ha)	29.60[a]	36.27[a]
T5(20ton/ha)	28.24[a]	35.85[a]
MEAN	27.58	33.57
SEM±	0.82	1.30
$LSD_{5\%}$	2.53**	4.03***
CV%	6	7.8

Means followed by the same letter(s) in a column are not significant at 5% level of significance as determined by DMRT.

Quality parameters

Effect of different doses of vermicompost on average root length and root diameter: The effect of different doses of vermicompost on average root length and root diameter of the radish crop is given in Table 2.

The Table 2 showed that the maximum root length (29.60 cm) was recorded in plot treated with T_4 (15 ton/ha vermicompost), which was at par with T_2 (5 ton/ha) and followed by T_3 (10 ton/ha) and T_5 (20 ton/ha). The minimum root length (23.42 cm) was recorded in the control (without vermicompost). Similarly, the maximum root diameter was recorded in plants of T_4 (15 ton/ha) treated plot followed by T_5 (20 ton/ha) and T_3 (10 ton/ha) while the lowest root diameter was observed in the T_1 (control) plot. Gupta, 2011 recorded radish grown in vermicompost applied plots gained higher root length which supports the findings of our study. Similar results were obtained in a study conducted by Politud (2016) who observed a greater root diameter of radish on applying 15 ton/ha vermicompost. The enhancement in yield attributes of radish due to the application of vermicompost is in line with the study conducted by Jaisankar, 2018 who recorded the maximum root length and root diameter on application of 12.5 ton/ha vermicompost.

Yield parameters

Average plant biomass (g/plant): The effect of different doses of vermicompost on radish (Mino Early) is presented in Table 3. The weight of the whole root along with leaves and without leaves was measured after the harvest of the crop. The maximum biomass (241.6 g) was recorded in plants applied with T_4-15 ton of vermicompost per hectare. This result was followed by a plot treated with T_3 (10 ton/ha) and T_5 (20 ton/ha) and the lowest biomass was obtained in the plot without application of vermicompost. The biomass weight of radish was at par with T_2-5 ton/ha (228.8 g), T_3-10 ton/ha (234.7 g), and T_5-20 ton/ha (231.4g). Similar results were obtained in a study conducted by Politud, 2016 who found the highest biomass of radish where 15 ton/ha vermicompost/ vermicast was applied.

Also, the maximum root weight (191.8g) was recorded in plants applied with 15 ton/ha vermicompost which was at par with 5 ton/ha (179.3 g/plant), 10 ton/ha (179.9 g/plant), and 20 ton/ha (184.9 g/plant). Control treatment (T_1) had the minimum root weight (74.1 g/plant).

Yield per plot and yield per hectare

The mean (Table 4) showed that the maximum root yield (47.9 ton/ha) was recorded in plants applied with 15 ton/ha vermicompost followed by a plot treated with T_5 and T_3 whereas the minimum root yield (18.5 ton/ha) was recorded in control. The production of radish was increased with increasing the doses of vermicompost which might be due to the availability of nutrients and also due to the availability of plant growth influencing materials, such as growth regulators, humic acid produced by the microbial population resulting from earthworm activity. Mahorkar *et al.* (2007) and Gupta *et al.* (2011) supported our findings, as they found the better yield was observed in plots applied with vermicompost than other organic manures in radish crop. Kumar and Gupta, 2018 during the study also reported the highest yield of radish on application of vermicompost. The findings of the study are in accordance with the study conducted by Jaisankar, 2018, who recorded the maximum root yield in radish on application of 12.5 ton/ha Vermicompost.

Table 3. Average plant biomass weight (g) and root weight (g) of radish as affected by different doses of vermicompost, in Bharatpur, Chitwan, 2020.

Treatment (doses of vermicompost)	Average plant biomass (g)	Average root weight (g)
T1(control)	119.3[b]	74.1[b]
T2(5ton/ha)	228.8[a]	179.3[a]
T3(10ton/ha)	234.7[a]	179.9[a]
T4(15ton/ha)	241.6[a]	191.8[a]
T5(20ton/ha)	231.4[a]	184.9[a]
MEAN	211.2	162.0
SEM±	12.78	10.61
$LSD_{5\%}$	39.39***	32.68***
CV%	12.1	13.1

Means followed by the same letter(s) in a column are not significant at 5% level of significance as determined by DMRT.

Table 4. Average root yield (kg/plot) and marketable root yield (ton/ha) as affected by different doses of vermicompost, at Chitwan, 2020.

Treatment (doses of vermicompost)	Average yield/plot (kg)	Average yield/ha (ton/ha)
T1(control)	3.71[b]	18.5[b]
T2(5ton/ha)	8.96[a]	44.8[a]
T3(10ton/ha)	9.0[a]	45.6[a]
T4(15ton/ha)	9.59[a]	47.9[a]
T5(20ton/ha)	9.25[a]	46.2[a]
MEAN	8.10	40.5
SEM±	0.53	2.65
$LSD_{5\%}$	1.63***	8.17***
CV%	13.1	13.1

Means followed by the same letter(s) in a column are not significant at 5% level of significance as determined by DMRT.

Conclusion

The application of vermicompost in radish production showed a positive effect on its growth and production. The highest leaf number per plant was 18.35 at 60 DAS in 10 ton/ha vermicompost. The highest plant height was recorded in 15 ton/ha vermicompost (25.79 cm). Similarly, 15 ton/ha vermicompost showed highest root length (29.60 cm) and highest root diameter (36.27 mm), maximum root yield 47.9 ton/ha at harvesting. Since there was no significant difference among different treatments (5 ton/ha, 10 ton/ha, 15 ton/ha and 20 ton/ha vermicompost application) in quality and yield of radish, so 5 ton/ha of vermicompost application was sufficient for radish production. Therefore, 5 ton/ha vermicompost could be used as the organic manure for increasing the productivity of the radish.

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